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**METHODOLOGY INVESTIGATION: TECHNICAL
EVALUATION OF FIELD ARTILLERY DIGITAL
AUTOMATIC COMPUTER (FADAC) TAPES**

Donald H. McCoy

**Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland**

13 August 1973

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13. ABSTRACT <p>This study was conducted by the Systems Analysis Directorate of Headquarters, US Army Test and Evaluation Command, for the purpose of demonstrating the need and feasibility of complete technical testing of revised FADAC tapes. Better technical testing was shown to be feasible and desirable. Recommendations were made to have Frankford Arsenal conduct completely automated technical tests.</p>			

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LINK A

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ROLE

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ROLE

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ROLE

WT

METHODOLOGY INVESTIGATION

FINAL REPORT

TECHNICAL EVALUATION OF

FIELD ARTILLERY DIGITAL AUTOMATIC COMPUTER (FADAC) TAPES

BY

DONALD H. McCOY
13 AUGUST 1973

FOREWORD. Acknowledgement is given to Ms. Joyce Brunsell for her computer support effort and Mrs. Evelyn Lidke and Mrs. Joyce Roszak for manuscript preparation.

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TABLE OF CONTENTS

	<u>PAGE</u>
ABSTRACT	111
FOREWORD	1v

SECTION I. SUMMARY

1. BACKGROUND	1
2. OBJECTIVES	1
3. DETAILS OF THE INVESTIGATION	1
4. CONCLUSIONS	2
5. RECOMMENDATIONS.	3

SECTION II. APPENDICES

A. CORRESPONDENCE	A-1
B. REFERENCES	B-1
C. DATA	C-1
D. DISTRIBUTION LIST.	D-1

SECTION I. SUMMARY

1. BACKGROUND.

This report concludes a methodology investigation concerning technical testing of Field Artillery Digital Automatic Computer (FADAC) tapes conducted by the Systems Analysis Directorate, US Army Test and Evaluation Command (TECOM). The Methodology Proposal is inclosed in Appendix A. The purpose of the investigation was to determine the feasibility of conducting a technical evaluation of revised FADAC tapes using an automated procedure.

These tapes are created by US Army Weapons Command (WECOM) (Software Engineering Branch, Fire Control Division, Frankford Arsenal) and tested by TECOM (the Field Artillery Board). During testing, problems of a technical nature and operational nature are being confounded. An attempt is made to simultaneously test the technical correctness of the revised tape, as well as user problems, i.e., the capability of man-machine interaction.

This work was done in conjunction with the Firing Tables Branch of the Ballistic Research Laboratories (BRL) and Frankford Arsenal (FA). BRL supplied the necessary trajectory data (see Appendix C); FA made the necessary FADAC runs. The major thrust of the Systems Analysis effort was to fully automate an already existing ballistic test procedure and to investigate other areas of testing where automation should be accomplished.

2. OBJECTIVES.

The primary objectives of this investigation are (1) to demonstrate that technical and service testing of revised FADAC tapes can and should be separated; and (2) to determine the feasibility of fully automating the technical testing.

3. DETAILS OF THE INVESTIGATION.

During the lifetime of FADAC, at least five major revisions have been implemented. Both Frankford Arsenal and the Field Artillery Board have stated that the testing situation is unsatisfactory. No effort is made in this study to ascertain the exact reasons. The pursuit of this task would be counterproductive. Hopefully, fully automated technical testing will alleviate the old problems associated with each revision of the FADAC tapes.

Frankford Arsenal has, in fact, partially automated the testing of ballistic programs for FADAC. This is done by operating two FADACs in a tandem arrangement (see Figure 1). One of the FADACs is used as an input/output (I/O) driver for the other FADAC, which is loaded with the ballistic program to be tested. The I/O driver replaces the man-in-the-loop. The driver bypasses the keyboard and causes the test results to be written on a teletype. The test is conducted free of operator error. This is an ideal situation for technical testing; i.e., testing which is conducted to determine if the FADAC is performing accurately for known test scenarios.

The Systems Analysis Directorate wrote a computer program to automatically generate the large number of inputs required for the Field Artillery Board automated ballistic test procedure. This program, contained in Appendix B, voids the requirement for Field Artillery Board to manually prepare exhaustive input in order to completely check out the ballistic programs. The complete test cycle is shown in Figure 2.

A sample of the output from this program is shown in Figure 3. The appearance of the output is rather confusing; however, once the basic concept is understood, it is really quite simple. A pair of digits addresses the particular position on the FADAC input matrix and the value required for input follows, separated by delimiters.¹

The output from this program is used to drive the ballistic test. Hardcopy output from a sample run is shown in Figure 4. A "C" in Column 1 indicates the correct solution. The "true" answers and the FADAC answers, labeled "F", which do not agree within a preset tolerance are flagged with a "\$\$".

In order to conduct the investigation, two basic training exercises were necessary. First, the format of the BRL tapes was studied. The BRL tapes contain trajectory data for a weapon/charge combination that are included in the FADAC programs. A conservative estimate of the number of cases run is 50,000. Second, the format of the automatic ballistic test program input had to be learned.

¹ A delimiter is a special character used to separate items in an input list. The delimiter in this case is a "+".

To test the concept, some 2,000 inputs for the 155mm Howitzer were generated. A subset of these 2,000 was randomly selected and run on the tandem FADACs. Sample inputs and outputs from these runs were as shown in Figures 3 and 4.

Approximately 60 problems per hour can be run in the auto-test mode, versus about 20 per hour in the manual mode. This timing consideration is important since there are at least 350 test problems that can be run for every weapon/ammunition charge/fuze combination. Also, testing in the automatic mode can be easily rerun and retesting in FADAC has been a common problem.

If the user and the developer cooperate in this effort, a test-bed or benchmark set of problems should evolve which will eliminate virtually all technical test problems.

4. CONCLUSIONS.

Since the trial with the ballistic procedure was successful, there is no reason to believe that other facets of technical testing will be unsuccessful. Additional work is required to automate the chronograph, registration, trilateration and survey programs.

5. RECOMMENDATIONS.

A letter has been sent to US Army Armament Command (ARMCOM) (see Appendix B) which includes the recommendations of this study. The recommendations are essentially the following:

- (1) Complete technical testing of revised FADAC tapes is required.
- (2) Technical testing should precede service testing.
- (3) Frankford Arsenal should be responsible for technical testing.
- (4) TECOM should observe all technical testing.
- (5) TECOM should conduct service tests upon satisfactory completion of technical tests.
- (6) Action should be taken to develop automated testing procedures for the survey, chronograph, trilateration, and registration problems.

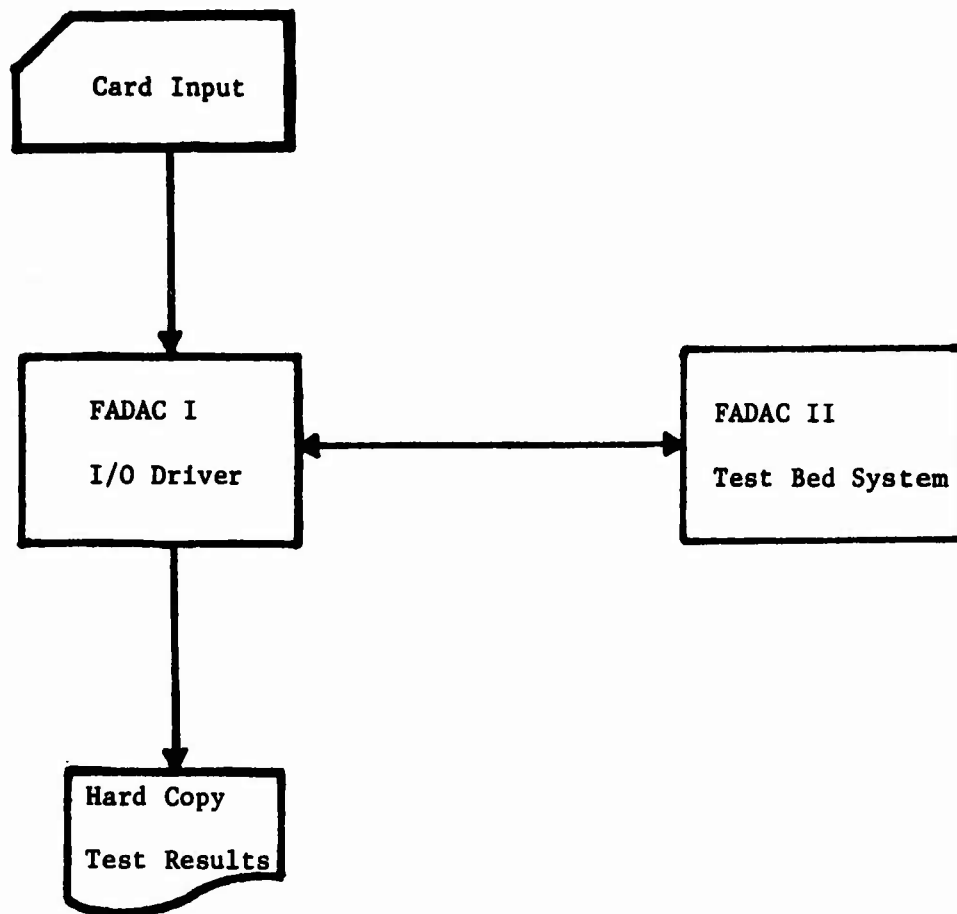


Figure 1. Auto-Ballistic Test Configuration

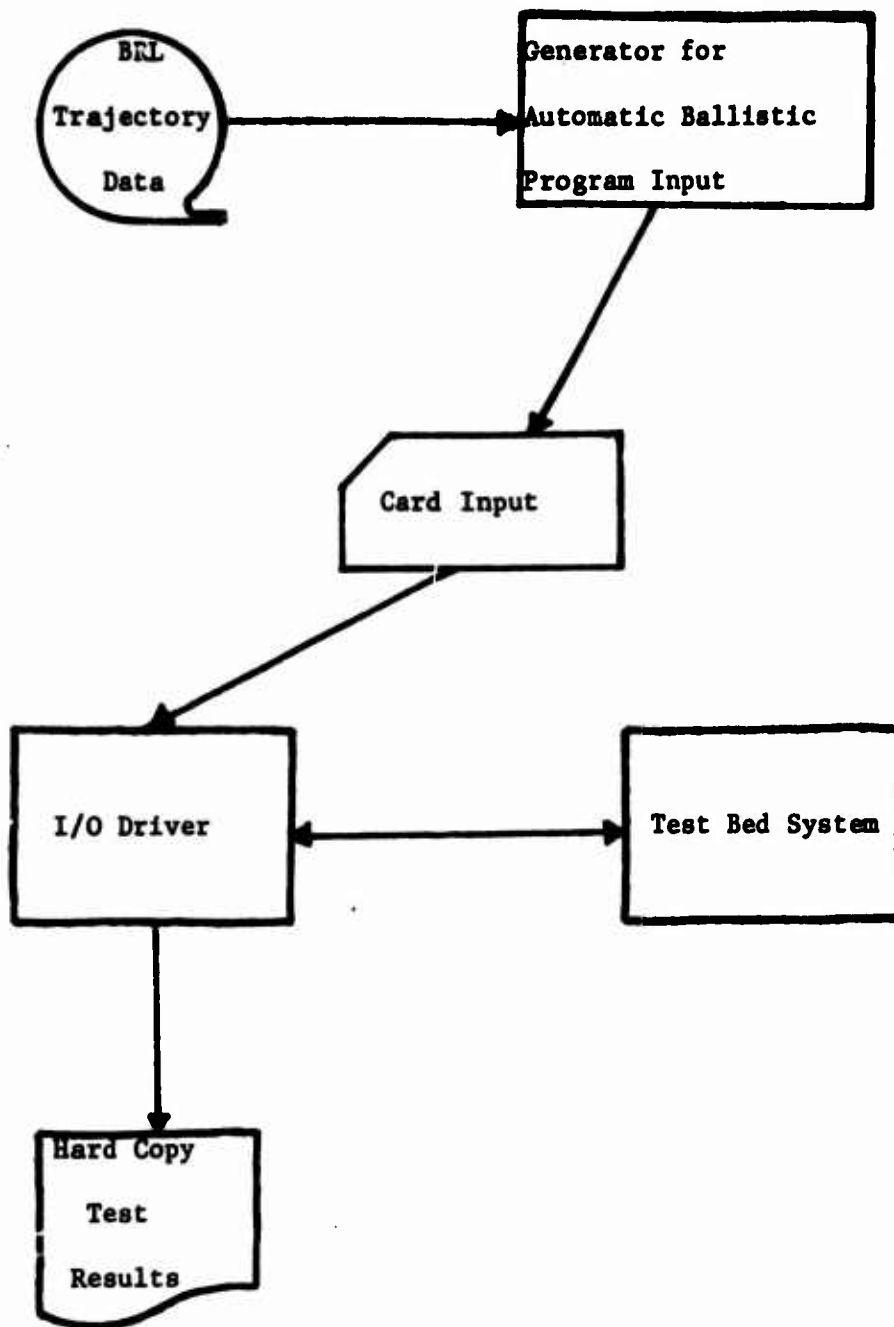


Figure 2. Automatic Input and Auto-Ballistic Test Configuration

EE1001+--99+21+1+22+9+23+9+26+1--45+1+3300+	1209+80+	50+--00+1+	2+ 6.3+ 20
EE1002+--99+21+1+22+9+23+9+26+2--45+1+3300+	1209+80+	30+--00+1+	2+ 6.5+ 20
EE1003+--99+21+1+22+9+23+9+26+3--45+1+3300+	1209+80+	30+--00+1+	2+ 6.0+ 20
EE1004+--99+21+1+22+9+23+9+26+7--45+1+3300+	1209+80+	30+--00+1+	2+ 6.2+ 20
EE1005+--99+21+1+22+0+23+9+26+1--45+1+3300+	2988+80+	50+--00+1+	38+34.8+110
EE1006+--99+21+1+22+0+23+9+26+2--45+1+3300+	2988+80+	30+--00+1+	38+35.3+110
EE1007+--99+21+1+22+0+23+9+26+3--45+1+3300+	2988+80+	50+--00+1+	38+35.0+110
EE1009+--99+21+1+22+0+23+9+26+7--45+1+3300+	2988+80+	30+--00+1+	38+34.4+110
EE2001+--99+21+1+22+0+23+9+26+1--45+1+0075+	3297+80+200+--00+1+	3228+36.3+110	
EE2002+--99+21+1+22+0+23+9+26+2--45+1+0075+	3297+80+180+--00+1+	3228+36.8+110	
EE2003+--99+21+1+22+0+23+9+26+3--45+1+0075+	3297+80+200+--00+1+	3228+36.0+110	
EE2004+--99+21+1+22+0+23+9+26+7--45+1+0075+	3297+80+180+--00+1+	3228+35.9+110	
EE3001+--99+21+1+22+0+23+9+26+1--45+1+6115+	2868+80+100+--00+1+	4830+34.1+110	
EE3002+--99+21+1+22+0+23+9+26+2--45+1+6115+	2868+80+	80+--00+1+	4830+34.5+110
EE3003+--99+21+1+22+0+23+9+26+3--45+1+6115+	2868+80+100+--00+1+	4830+34.0+110	
EE3004+--99+21+1+22+0+23+9+26+7--45+1+6115+	2868+80+	80+--00+1+	4830+33.7+110
EE4001+--99+21+1+22+0+23+9+26+1--45+1+4435+	3302+80+150+--00+1+	1631+36.3+110	
EE4002+--99+21+1+22+0+23+9+26+2--45+1+4435+	3302+80+130+--00+1+	1631+36.9+110	
EE4003+--99+21+1+22+0+23+9+26+3--45+1+4435+	3302+80+150+--00+1+	1631+36.0+110	
EE4004+--99+21+1+22+0+23+9+26+7--45+1+4435+	3302+80+130+--00+1+	1631+35.9+110	

Figure 3. Sample Input for the Auto-Ballistic Test

2201

PR #2101	COMP				
CD CHG	DE FL	TF	QE		
V C 1	2	6.3	200		
F 1	2	6.4	200		
PR #1001	COMP				
CD CHG	DE FL	TF	QE		
V C 1	2	6.3	200		
V F 1	2	6.4	200		
PR #2201	COMP				
CD CHG	DE FL	TF	QE		
C 1	3228	36.3	1100		
F 1	3228	36.3	1100		
PR #2001	COMP				
CD CHG	DE FL	TF	QE		
C 1	28	36.3	1100		
F 1	3235	37.6	1115		\$\$
PR #2301	COMP				
CD CHG	DE FL	TF	QE		
C 1	4830	34.5	1100		
F 1	4830	34.4	1100		
PR #3001	COMP				
CD CHG	DE FL	TF	QE		
V C 1	30	34.1	1100		
F 1	4833	34.5	1106		\$\$
PR #2401	COMP				
CD CHG	DE FL	TF	QE		
C 1	1631	36.0	1100		
F 1	1631	36.0	1100		
PR #4001	COMP				
CD CHG	DE FL	TF	QE		
C 1	31	36.3	1100		
F 1	1636	37.2	1110		\$\$

Figure 4. Sample Output for the Auto-Ballistic Test

SECTION II. APPENDICES

APPENDIX A. CORRESPONDENCE

COPY

DISPOSITION FORM

AMSTE-ME

SUBJECT: Technical Evaluation of FADAC Tapes

TO Dir, Systems Analysis FROM Math Imprv Dir DATE 29 Mar 74 CMT 1
LTC Stone/dg/5145

1. Request you conduct subject investigation in accordance with the attached Methodology Investigation Proposal.
2. Funds in the amount of \$3,500 have been authorized to support the effort. These funds include \$1,000 to support travel. In order to cite these funds the methodology X Order should be used in conjunction with the Systems Analysis Cost Center. The remaining funds are designated for the support of field effort in the event it is decided to task APG computer program preparation. In such cases the funds will be distributed to APG as needed by this Directorate.

1 Incl
MIP

/s/ W. L. Stone LTC
/for/ SIDNEY WISE
Director

COPY

Systems Analysis Directorate
US ARMY TEST AND EVALUATION COMMAND

Methodology Investigation Proposal, FY 73
9 March 1973

1. TITLE: Technical Evaluation of FADAC Tapes.
2. INSTALLATION: HQ, TECOM.
3. PRINCIPAL INVESTIGATOR: Donald H. McCoy, Systems Analysis Directorate, AMSTE-SY, AUTOVON 870-2093.
4. STATEMENT OF THE PROBLEM: WECOM periodically provides new tapes for the FADAC fielded system. This action establishes the precedence for TECOM's role in post-deployment of all future fielded computer systems. The current testing program at the Field Artillery Board combines both technical and user evaluation of a new FADAC tape. For the latest revision, five weeks per tape is required to conduct the evaluation. A significant portion of this time is used to input a large number of test cases by hand. This study will investigate the feasibility of conducting technical evaluation of FADAC tapes automatically.
5. DESCRIPTION OF THE INVESTIGATION.
 - a. Systems Analysis Directorate will determine whether the technique currently used by Frankford Arsenal to evaluate new FADAC tapes can be extended to permit direct inputting of BRL trajectory data (on tape) into FADAC. Currently, Frankford Arsenal tests new tapes by connecting two FADACs in tandem, and using one FADAC as the input/output driver to the other FADAC. The input to FADAC must be keypunched from BRL printouts and converted to paper-type.
 - b. Systems Analysis Directorate will determine the feasibility of preparing a computer program that will convert the BRL tape format into the FADAC input format. If it is estimated that 0.5 manmonths of effort is required to write the computer program, Analytic Branch, MTD will be tasked to prepare the computer program. If APG does not have the resources available to complete the task in the required time frame, Systems Analysis Directorate will prepare the program.
 - c. Upon completion of the conversion program, the tape for the M109A1 will be evaluated using two FADACs in tandem. This will conclusively establish the feasibility of conducting technical evaluation of FADAC tapes automatically.
 - d. A TOP will be prepared detailing the procedures for the technical evaluation of FADAC tapes.

7. JUSTIFICATION: A significant reduction of total test time will result if TECOM can evaluate the technical aspects of PADAC tapes automatically. Furthermore, a more thorough checkout of the tapes can be performed by using more test cases.

9. RESOURCES REQUIRED:

<u>Manmonths</u>	<u>Source</u>	<u>Salaries</u>	<u>TDY</u>
2	HQ, TECOM		1000
1	APG	2000	500
			<u>1500</u>

10. SCHEDULE: Final report due 30 June 1973.

COPY

Mr. McCoy/em1/2093

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30 JUL 1973

SUBJECT: Technical Testing of Revised FADAC Tapes

Commander

US Army Armament Command

Rock Island, Illinois 61201

1. Reference conversation between CG, TECOM, and CG, ARMCOM, on above subject at the AMC Summer Commanders' Conference on 13 July 1973, and meetings held between Mr. Harold Brodtkin, Fire Control Development and Engineering Directorate, Frankford Arsenal, and Mr. Donald H. McCoy Headquarters, TECOM, on 15 February, 16 April, 17 May, and 23 May 1973.

2. Background.

a. The Field Artillery Digital Automatic Computer (FADAC) is a fire control computer for cannon artillery. The computer is a second generation device with limited memory (8,192 words), utilizing machine language programming. The FADAC peripheral devices include a keyboard input, low-speed paper tape, high-speed paper tape, and a teletype output.

b. Frankford Arsenal (FA) has the responsibility for providing software (cannon program tapes) for the FADAC system. This includes ballistic programs, as well as auxiliary functions like the survey and transfer programs. FA coordinates the need with the user before updating and revising these programs. TECOM (the Field Artillery Board) has the responsibility for product improvement tests of these tapes.

c. Since the original fielding of FADAC, the cannon programs have been updated and reissued at least five times. Theoretically, there should be no technical errors in these tapes when they are released to TECOM for testing. On every release, however, major problems have been found by the Field Artillery Board (FABD). This means FA must correct the software and send the corrected tape to the FABD for retesting. This Headquarters believes the "find-fix loop" can be avoided by a thorough technical test of the software tapes prior to the FABD tests.

d. FA has taken the basic steps toward an automated technical test procedure by automating a ballistic test routine. This routine uses one FADAC

AMSTE-SY

30 JUL 1973

SUBJECT: Technical Testing of Revised FADAC Tapes

computer as an input/output driver for testing the ballistic routines. A similar procedure can and should be developed for the survey, trilateration, chronograph and K-transfer programs.

e. The Systems Analysis Directorate at this Headquarters has written a computer program which augments the FA automated ballistic test procedure. This program is designed to automatically create input to the FA test program from Ballistic Research Laboratories (BRL) test data tapes. In the past, hand preparation of the BRL input on punched cards was prohibitive, and precluded a complete technical test of a ballistic tape for all fuze/projectile combinations. The automatic preparation of these inputs means that a complete technical test of a ballistic tape can now be easily accommodated in a timely and efficient manner.

3. As indicated by the reference above, TECOM and FA have been actively working to solve some mutual problems. The solutions to these problems concerning technical testing of FADAC software require a more formal arrangement between ARMCOM and TECOM. Therefore, TECOM recommends that:

a. TECOM and ARMCOM initiate action to develop a mutually agreeable baseline for an automated technical test procedure for FADAC tapes.

b. FA be responsible for the technical testing, to include a complete check of the ballistic programs and all auxiliary functions.

c. TECOM witness these tests.

d. Upon completion of technical testing, these tapes be submitted to TECOM for service testing.

e. Action be taken to develop automated testing procedures for the survey, chronograph, trilateration and K-transfer programs.

4. The Systems Analysis Directorate, Headquarters, TECOM, will continue to actively support the automation aspects of this effort. The technical point of contact is Mr. Donald H. McCoy, AUTOVON 870-2093.

5. The Field Artillery Materiel Testing Directorate, Headquarters, TECOM, will provide technical assistance and will effect coordination with the Field Artillery Board. The point of contact is Mr. Emmet O'Brien, AUTOVON 870-4875.

CHARLES P. BROWN
Major General, USA
Commanding

A-5

CF:
Cdr, Frankford Arsenal
ATTN: SARFA-N-7400 (Mr Brodtkin)

APPENDIX B. REFERENCES

1. FM 6-40-3, Operation of the Gun Direction Computer M18, Cannon Gunnery Application, August 1970.
2. Theodore Lafferty, Jr. and Harry Onsey, Cannon Artillery Ballistic Programs for Computer, Gun Direction, M18 (FADAC). Report R-1976, Frankford Arsenal, July 1970.

APPENDIX C. DATA

1. FADAC PROGRAM:

```

DIMENSION A(40),R(20,50),MARK(20)
DIMENSION BUFF(20),IDF (4),IDELY(4)
DIMENSION IGTA7(4),METN(4),IFT(4),LMFT(4)
INTEGER CHGTYP,TRAJNO,CT1,CT2
DATA IGTA7/'3317','0075','6115','4435'/
DATA METN/'F','G','H1','H2'/
DATA IFT/1,2,3,7/
DATA IDELY/3,18,8,13/
DATA IDF /0,3200,4800,1600/
DATA CT1,CT2,PLNK/'0 50','A' , 'D' , 'G' , ' ' /
DATA TRAJ/'0A'/
DATA MARK /20*'1234'/
DATA LMFT/4*1/
LL=0
DO 9 L=1,10
1 READ(9,2,FRR=99,FND=99)A
2 FORMAT(4A4)
IF((A(15).NE.TRA).AND.(A(35).NE.TRA))GO TO 1
IF(A(35).EQ.TRA) GO TO 12
DO 3 I=1,20
R(I,1)=A(I)
3 R(I,2)=A(I+20)
JSTART=3
GO TO 13
12 DO 14 I=1,20
14 R(I,1)=A(I+20)
JSTART=2
13 DO 4 J=JSTART,49,2
JDEL=J-1
READ(9,2,FRR=99,FND=99)A
IF(A(15).EQ.TRA) GO TO 5
IF(A(35).EQ.TRA) GO TO 15
DO 6 I=1,20
R(I,J)=A(I)
6 R(I,J+1)=A(I+20)
GO TO 4
15 JDEL=JDEL+1
DO 16 I=1,20
16 R(I,J)=A(I)
GO TO 5
4 CONTINUE
5 N=JDEL
BACKSPACE 9
WRITE(6,7)MARK
7 FORMAT(1X,20A4)
DO 8 J=1,N
WRITE(6,7)(R(I,J),I=1,20)
8 CONTINUE
LEN=90
NOUN=1
IF(R(7,N).EQ.0SD.OP.R(7,N-3).EQ.0SD)GO TO 9
CALL CORF(BUFF,LEN)
WRITE(NOUN,31)(R(K,1),K=1,20)

```

```

      CALL CORE(BUFF,LEN)
      READ(NDUM,32)TRAJNO,MFT
31  FORMAT(20A4)
32  FORMAT(11X,12,A2)
      IF(MFT.EQ.META)GO TO 9
      CALL CORE(BUFF,LEN)
      WRITE(NDUM,31)(R(K,11),K=1,20)
      CALL CORE(BUFF,LEN)
      READ(NDUM,33)IQF
33  FORMAT(2X,14)
      IF(IQF.GT.800)GO TO 34
      LOHI=9
      GO TO 35
34  LOHI=0
35  CALL CORE(BUFF,LEN)
      WRITE(NDUM,31)(R(K,12),K=1,20)
      CALL CORE(BUFF,LEN)
      READ(NDUM,36)ICHGNO,CHGTYP
36  FORMAT(46X,11,A1)
      IF(CHGTYP.EQ.0T1)CHGTYP=0
      IF(CHGTYP.EQ.0T2)CHGTYP=9
      JREC=N-1
      IF(R(1,N).EQ.BLNK)JREC=N-4
      CALL CORE(BUFF,LEN)
      WRITE(NDUM,31)(R(K,JREC),K=1,20)
      CALL CORE(BUFF,LEN)
      READ(NDUM,37)IQF,IF,DEFL
37  FORMAT(F8.0,9X,15,15X,F6.0)
      IDEFL=DEFL+.5
      IQF=IQF+.5
      TF=IQF
      JREC=JREC+1
      CALL CORE(BUFF,LEN)
      WRITE(NDUM,31)(R(K,JREC),K=1,20)
      CALL CORE(BUFF,LEN)
      READ(NDUM,38)FS1,FS2
38  FORMAT(38X,2F6.0)
      WRITE(6,39)TRAJNO,MFT,IQF,LOHI,ICHGNO,CHGTYP,IF,IDEFL,IQF,FS1,
      FS2
39  FORMAT(//1X,12,1X,A2,1X,7(15,1X),2(F6.2)//)
      DO 40 JMFT=1,4
      IF(MFT.NE.MFTN(JMFT)) GO TO 40
      IGT=IGTAZ(JMFT)
      LL=LJMT(JMFT)
      LJMT(JMFT) = LJMT(JMFT) + 4
      IDEFL=IDEFL+IQF(JMFT)
      GO TO 45
40  CONTINUE
45  DO 41 LOPP=1,4
      IPN=JMFT*1000+LL+LOPP-1
      IV=IDEFL(JMFT)
      IFZTYP=IFZT(JMFT)
      IF(IFZT(JMFT).EQ.1) IV=IV+20
      IF(LOPP.EQ.3) GO TO 42
      IF (LOPP.EQ.1) FS = IQF
      IF (LOPP.EQ.2) FS=FS2
      IF(LOPP.EQ.4) FS=FS1
      WRITE(6,43) IPN,ICHGNO,LOHI,CHGTYP,IFZTYP,IGT,IF,IV,ICHGNO,
      *IDEFL,FS,IQF
      WRITE(7,53) IPN,ICHGNO,LOHI,CHGTYP,IFZTYP,IGT,IF,IV,ICHGNO,
      *IDEFL,FS,IQF

```

```

43 FORMAT('  &&',I4, '  ,--99+21+',I1,'+22+',I1,'+23+',I1,'+26+',I1,
1'+'--45+1+',A4,'+',I5,'+&0+',I3,'+'--00+',I1,'+',I4,'+',
2F4.1,'+',I4,'+')
53 FORMAT('  &&',I4, '  ,--99+21+',I1,'+22+',I1,'+23+',I1,'+26+',I1,
1'+'--45+1+',A4,'+',I5,'+&0+',I3,'+'--00+',I1,'+',I4,'+',
2F4.1,'+',I4,'+')
GO TO 41
42 IF (LOHI.EQ.0) IY=IY+20
WRITE(6,43) IPN,ICHGNO,LOHI,CHGTYP,IFZTYP,IGT,IE,IY,ICHGNO,
1IDEFL,TF ,IQE
WRITE(7,53) IPN,ICHGNO,LOHI,CHGTYP,IFZTYP,IGT,IE,IY,ICHGNO,
1IDEFL,TF ,IQE
41 CONTINUE
9 CONTINUE
GO TO 99
98 WRITE(6,17)A
17 FORMAT(1X,20A4//20A4)
WRITE(6,18)
18 FORMAT(' ERR ACTION LABEL')
DEBUG SUBCHK
99 CALL EXIT
END

```

2. SAMPLE TRAJECTORY DATA:

TRAJECTORY NO. 2A

155MM, HE, M107/M114A1

FLV	STD. MV	STD. WT	DEL MV	P.T.	DEL WT	N	ACT. MV	ACT. WT
FALL.	LAT	A7	HGT TGT	HGT MDP	CHARGE			
MILS	M/S	LB	M/S	DEG F	LB	FACTOR	M/S	LB
COFF.	DEG	MILS	M	M				
1100.	207.3	95.00	0.0	70.	0.0	-0.460	207.30	95.00
2-106	40.	1095.	0.	0.	1G			

CORR.	RANGE	F1	F2	F3	DEFL	U	U1	U2	U3	U100T
U200T	U300T	KD	MACH	RETARD	FS					
TOF										
SEC	M	M	M	NO.	COEFF.	MILS	M/S	M/S	M/S	M/S**2
M/S**2	M/S**2				1/SEC	M564	M520			
0.00	0.	0.	0.	0.	0.	0.00	207.3	97.7	182.8	0.0
-11.4	-0.00	0.0500	0.61	-0.0086	-0.1	0.1				-0.9
1.01	97.	97.	177.	-0.	0.15	197.0	96.9	171.6	-0.0	-0.8
-11.2	-0.00	0.0500	0.58	-0.0090	0.9	1.1				
2.02	194.	194.	343.	-0.	0.32	197.1	96.1	160.5	-0.0	-0.7
-11.0	0.00	0.0500	0.55	-0.0075	1.9	2.1				
3.02	290.	290.	498.	-0.	0.49	177.4	95.4	149.6	0.0	-0.7
-10.9	0.00	0.0500	0.52	-0.0070	2.9	3.1				
4.03	385.	385.	642.	0.	0.68	168.1	94.8	138.8	0.0	-0.6
-10.7	0.00	0.0500	0.50	-0.0065	3.9	4.1				
5.04	479.	479.	776.	0.	0.89	159.0	94.2	128.2	0.0	-0.6
-10.6	0.00	0.0500	0.47	-0.0061	4.9	5.2				
17.84	1639.	1639.	1589.	0.	5.58	89.2	89.2	0.0	0.1	-0.3
-9.8	0.01	0.0500	0.27	-0.0032	17.6	18.1				
36.37	3207.	3207.	-0.	3.	42.98	188.2	81.7	-160.6	0.3	-0.6
-8.5	0.01	0.0500	0.55	-0.0078	36.0	36.8				